~~METHOD FOR MANUFACTURING~~ MAGNETIC FIELD DETECTING ELEMENT AND METHOD FOR MANUFACTURING THE SAME

~~CROSS-REFERENCE TO RELATED APPLICATIONS~~

~~This application claims the benefit of Korean Patent Application No. 2003-11807 filed February 25, 2003, Korean Patent Application No. 2003-34191 filed May 28, 2003, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.~~

~~**BACKGROUND**~~

BACKGROUND OF THE INVENTION

~~1. Field of the Invention~~

1. Field of the Invention

[0001] The present invention relates to a magnetic field detecting element and ~~The present invention relates to~~ a method for manufacturing the same. More particularly, the present invention relates to a magnetic field detecting ~~device~~element and a method for manufacturing the same by forming a soft magnetic core and a coil in a thin film type on a semiconductor substrate using a semiconductor process.

2.- Description of the Related Art

[0002] ~~A~~ Conventionally, a high sensitivity magnetic sensor ~~using~~has included a soft magnetic material and a coil ~~has been used as~~. Such a magnetic sensor ~~of high sensitivity for a long time. Such magnetic sensor is usually~~is generally manufactured by winding a coil ~~wound~~ on a soft magnetic core, and requires an electronic circuit for obtaining a magnetic field proportional to a measured magnetic field. Recently, a method for realizing a magnetic field detecting element of such ~~magnetic filed detecting element of the~~ a magnetic sensor ~~in form of the~~ has been suggested, in which a soft magnetic thin film core and a plane thin film coil are formed on ~~the~~a semiconductor substrate using ~~the~~ a semiconductor process~~, has been suggested~~.

[0003] A general method for manufacturing a magnetic field detecting element using ~~the~~ a semiconductor process ~~will be briefly described with reference to FIG.~~is illustrated in FIGS. 1A through ~~FIG.~~ 1J ~~in the following.~~.

[0004] ~~On the first place, as shown in FIG.~~Referring to FIG. 1A, ~~the~~ a first seed film 2 is formed on a semiconductor substrate 1. ~~After a~~ A photoresist of a predetermined height (not shown) is ~~spread~~ formed on the first seed film 2~~, the~~. In FIG. 1B, a first plating mold 3 having a plurality of grooves 3a is formed by exposing and developing ~~processes as shown in FIG. 1B. After that, metal is~~

~~filled up in the groove~~ the photoresist. Next, the grooves 3a of the first plating mold 3 ~~through the~~ are filled with metal by a process ~~such as an~~, e.g., electric plating, so that a plurality of coil lines 4a, 4b~~,... may be~~, etc. are formed, as shown in FIG. 1C. ~~After that~~ Then, the first plating mold 3 and the seed film under the first plating mold 3 are removed ~~so that the~~, thereby forming a first coil 4 consisting of a plurality of coil lines 4a, 4b~~,... that~~, etc., which are insulated from each other ~~may be formed~~, as shown in FIG.-_1D.

[0005] After the first coil 4 is formed, ~~the~~ a first insulating film 5 is formed ~~at the height higher than the height of~~ to cover the first coil 4 on the semiconductor substrate 1, as shown in FIG. 1E. ~~After that~~ Then, a soft magnetic material film ~~is spread~~ (not shown) is formed on ~~the~~an upper ~~part~~surface of the first insulating film 5, and the soft magnetic material film is patterned and etched to form a soft magnetic core 6 ~~is formed by a pattern formation and etching (refer to~~, as shown in FIG. 1F~~)~~.

[0006] Subsequently, a second insulating film 7 of a predetermined thickness is formed on the soft magnetic core 6 of the semiconductor substrate 1, as shown in FIG. 1G~~, and~~. Then, as shown in FIG. 1H, via holes 8a~~,~~ and 8b for communicating with the coil lines 4a~~,~~ and 4o ~~forming both ends~~at either end of

the first coil 4, are formed, and a second seed film 9 is formed ~~in~~ to a predetermined thickness on ~~the~~an upper ~~part~~surface of the second insulating film 7~~, then~~. Next, a ~~photoresist is spread~~ thick photoresist (not shown) is formed on the second seed film 9 and ~~the~~ a second plating mold 10 having a plurality of grooves 10a and having the via holes 8a, 8b formed therethrough is formed by exposing and developing ~~processes.~~the thick photoresist.

[0007] ~~After that, as~~As shown in FIG. 1I, metal is ~~filled up in the groove~~ formed in the plurality of grooves 10a of the second plating mold 10 so that a plurality of coil lines 11a, 11b~~,...may be~~, etc. is formed. Then, the second plating mold 10 and the second seed film 9 under the second plating mold 10 are removed ~~so that the~~, thereby forming a second coil 11 consisting of ~~a~~ the plurality of coil lines 11a, 11b~~,...that~~, etc., which are insulated each other ~~may be formed~~, as shown in FIG. 1J.

[0008] ~~Lastly,~~ Finally, although not shown ~~in the drawing~~, a protection film is spread on ~~the~~ an upper ~~part~~portion of the second coil 11, whereby manufacturing of the magnetic field detecting element is complete~~d~~.

[0009] ~~But~~However, according to the foregoing general method for manufacturing the magnetic field detecting element, the seed film 2 between the

coil lines 4a, 4b~~,...~~, etc. should be removed ~~in order for each coil line~~ so that the coil lines 4a, 4b~~,...~~, etc. constituting the first coil 4 ~~to be~~ are insulated from each other. For that purpose, after the first plating mold 3 is removed, the ~~process of spreading the~~ insulating film 5 ~~again is added for the~~ must be formed on the first coil 4 for subsequent process~~, whereby~~es, thereby complicating the manufacturing process ~~is complicated.~~.

[0010] ~~In the meantime, the~~In addition, performance of the soft magnetic core 6 in the foregoing magnetic field detecting element~~, is not very good in case that~~ is poor because the semiconductor substrate 1 for supporting the soft magnetic core ~~is not even.~~6 is uneven. Since ~~having such structure that~~ the first coil 4 is projected ~~on~~onto the semiconductor substrate 1, the general magnetic field detecting element has ~~weak point~~ a weakness in that the thickness of the first and the second insulating films 5, 7 ~~for insulation and planarization,~~ ~~becomes~~may become thick. If the ~~thickness of the~~ insulating films 5, 7 ~~becomes~~ become thick, not only does the ~~whole thickness of the~~entire element become~~s~~ thick, but ~~also~~ the process for forming the via holes 8a, 8b ~~for connecting~~, which connect the first coil 4 with the second coil 11, becomes difficult. Also, a pitch between the coil lines ~~that has an influence on the~~, which

influences performance of the sensor ~~gets~~ becomes large, ~~which shows a~~ causing further negative effects in the element.

SUMMARY OF THE INVENTION

[0011] ~~Accordingly, the present invention has been made to solve the above-mentioned problems occurring in the conventional art, and~~ The present invention is therefore directed to a magnetic field detecting element and a method for manufacturing the same, which substantially overcome one or more of the problems due to the limitations and disadvantages of the related art.

[0012] It is a feature of an ~~object~~embodiment of the present invention ~~is~~ to provide a method for manufacturing a magnetic field detecting element~~, wherein~~ having a simple manufacturing process ~~is simple and there are small restrictions~~, in ~~materials usable for an insulating film since~~ which a plating mold needs not ~~to~~ be removed for removal of ~~the~~ a seed film ~~for~~ to provide insulation between coil lines, thereby reducing restrictions on a material suitable for use as an insulating film.

[0013] It is another ~~object~~feature of an embodiment of the present invention ~~is~~ to provide a method for manufacturing a magnetic field detecting element~~, capable of easily performing planarization~~ having a simple manufacturing process, in

which planarization of ~~the~~ a semiconductor substrate on which a coil is formed may be easily performed, and ~~of simplifying the process since the~~ in which a thickness of ~~the~~ a planarization material ~~is thin,~~ and ~~of~~ a film for constructing the magnetic field detecting element ~~in a~~are thin~~ film type as well~~.

[0014] ~~The foregoing~~It is still another feature of an embodiment of the present invention to provide a magnetic field detecting element having improved performance manufactured by a simplified process.

[0015] At least one of the above and other ~~objects~~features and advantages ~~are~~ of the present invention may be realized by providing a method for manufacturing a magnetic field detecting element ~~consisting of~~having a soft magnetic core formed on a semiconductor substrate~~; a~~, first and ~~a~~ second coils arranged on ~~the~~ upper and ~~the~~ lower ~~parts~~surfaces of the soft magnetic core, respectively, the first and second coils each having a plurality of coil lines, ~~respectively,~~ the method ~~comprising the steps of:~~including forming a seed film ~~of~~ to a predetermined thickness on the semiconductor substrate~~;~~, removing a portion of the seed film ~~in~~using a predetermined pattern so that ~~a~~ each of the plurality of ~~the~~ coil lines constituting the first coil that ~~would be~~is subsequently formed on a remaining portion of the seed film ~~may be partitioned each other;~~is

separated from the others, forming a first plating mold having a plurality of grooves ~~that corresponds~~corresponding to the predetermined pattern, on an upper ~~part~~portion of the seed film~~;~~, forming ~~a~~ the plurality of ~~the~~ coil lines constituting the first coil by filling ~~up~~ the plurality of grooves of the first plating mold with metal ~~in~~ , forming the ~~groove of the first plating mold; forming a~~ soft magnetic core and the second coil on an upper ~~part~~portion of the semiconductor substrate and on the remaining portion of the seed film where the first coil is formed~~;~~, and cutting off ~~four~~ edges of the semiconductor substrate so that ~~a~~ each of the plurality of ~~the~~ coil lines ~~partitioned~~separated by the predetermined pattern ~~may be~~ are insulated from each other.

[0016] ~~The step~~Removing the portion of ~~removing~~ the seed film may further ~~comprises the steps of: spreading a~~ include forming a photoresist layer on an upper surface of the seed film~~; forming a predetermined pattern that would be removed, by~~, exposing and developing the photoresist~~;~~ to form the predetermined pattern, and etching the seed film according to the predetermined pattern.

[0017] ~~Also, metal is filled up in~~Filling the ~~groove~~plurality of grooves of the first plating mold with ~~use of an~~metal may include electric plating.

[0018] ~~Also, the step of forming a soft magnetic core further comprises~~Forming the ~~steps of: performing planarization of~~soft magnetic core may further include planarizing an upper surface of the semiconductor substrate on which the first coil is formed~~;~~, spreading an insulating film on ~~an~~the planarized upper surface of the semiconductor substrate~~ for which planarization has been performed;~~, spreading a soft magnetic material film on an upper ~~part~~surface of the insulating film~~;~~, forming a ~~pattern of a soft magnetic core through exposing and developing processes after spreading a~~ photoresist layer on the soft magnetic material film and exposing and developing the photoresist layer to form a pattern of the soft magnetic ~~material film;~~core, and etching the soft magnetic material film according to the pattern.

[0019] ~~Also,~~Forming the ~~step of forming a~~ soft magnetic core ~~could also be realized by other method comprising the steps of:~~may include removing the first plating mold~~; spreading~~, forming an insulating film ~~at~~to a height ~~higher~~greater than a height of the first coil~~,~~ on an upper ~~part~~surface of the semiconductor substrate from which the first plating mold has been removed~~;~~, spreading a soft magnetic material film on an upper ~~part~~surface of the insulating film~~;~~, forming a ~~pattern of a~~photoresist layer on the soft magnetic ~~core through~~ material film and

exposing and developing ~~processes after spreading a photoresist on~~ the photoresist layer to form a pattern of the soft magnetic ~~material film;~~core, and etching the soft magnetic material film according to the pattern.

[0020] ~~According to a preferred embodiment~~At least one of the ~~present invention, the foregoing~~above and other ~~objects~~features and advantages ~~are~~ of the present invention may be realized by providing a method for manufacturing a magnetic field detecting element ~~consisting of~~having a soft magnetic core formed on a semiconductor substrate~~; a~~, first and ~~a~~ second coils respectively arranged on upper and lower ~~parts~~surfaces of the soft magnetic core, ~~and~~the first and second coils each having a plurality of coil lines, ~~respectively,~~ the method ~~comprising the steps of:~~including forming a first seed film ~~of~~to a predetermined thickness on the semiconductor substrate~~;~~, removing a portion of the first seed film ~~in~~using a predetermined first pattern so that ~~a~~ each of the plurality of coil lines constituting the first coil ~~that would be~~to be subsequently formed on the first seed film ~~may be partitioned each other;~~is separated from the others, forming a first plating mold having a plurality of grooves that ~~correspond~~corresponds to the predetermined first pattern, on an upper ~~part~~portion of the first seed film~~;~~, forming a the plurality of coil lines constituting

the first coil by filling ~~up metal in the groove~~the plurality of grooves of the first plating mold~~;~~ with metal, forming ~~a~~ the soft magnetic core on the semiconductor substrate where the first coil is formed~~;~~, forming a second insulating film on the semiconductor substrate where the soft magnetic core is formed~~;~~, forming a second seed film on an upper surface of the second insulating film~~;~~, removing the second seed film ~~in~~using a predetermined second pattern so that a plurality of coil lines constituting the second coil ~~that would~~to be subsequently formed on the second seed film ~~may be partitioned~~are separated from each other~~;~~, forming a second plating mold having a plurality of grooves ~~that corresponds~~corresponding to the second pattern, on an upper ~~part~~portion of the second seed film~~;~~, forming a plurality of coil lines constituting the second coil by filling ~~up metal in the groove~~the plurality of grooves of the second plating mold~~;~~ with metal, and cutting off edges on ~~four~~ sides of the semiconductor substrate so that ~~a~~ each of the plurality of ~~the~~ coil lines constituting the first and the second coils ~~partitioned~~separated by the first and the second patterns ~~may be~~ are insulated from each other.

~~According to another embodiment of the present invention, the foregoing and other objects and advantages are realized by providing a method~~

~~for manufacturing a magnetic field detecting element including the steps of: forming a first coil on an upper part of a semiconductor substrate; after forming a soft magnetic core on an upper part of the first coil with an insulating film intervened, forming a second coil on an upper part of the soft magnetic core with another insulating film intervened, the method comprising the step of: after forming a well of a predetermined dept on the semiconductor substrate, arranging the first coil in an inside of the well lest the first coil should be projected to a surface of the semiconductor substrate.~~

~~According to still another embodiment of the present invention, the foregoing and other objects and advantages are realized by providing a method for manufacturing a magnetic field detecting element comprising the steps of: preparing a semiconductor substrate; forming a well of a predetermined dept on the semiconductor substrate; forming a first coil consisting of a plurality of coil lines in the inside of the well of the semiconductor substrate; forming a first insulating film on an upper part of the semiconductor substrate including the well; forming a soft magnetic core on an upper part of the first insulating film; forming a second insulating film on an upper part of the first insulating film including the soft magnetic core; and forming a second coil that corresponds to~~

~~the first coil, on an upper part of the second insulating film.~~

~~Here, it is preferable that the well is formed in such a way that the well has an inclined sidewall that is gradually inclined in its inside from its upper part to its bottom by the etching process.~~

[0021] ~~Also, the step of forming the first coil further comprises the steps of:~~Filling the plurality of grooves of the first and the second plating molds with metal may include electric plating.

[0022] Forming the soft magnetic core may further include planarizing an upper surface of the semiconductor substrate on which the first coil is formed, spreading a first insulating film on the planarized upper surface of the semiconductor substrate, spreading a soft magnetic material film on an upper portion of the first insulating film, forming a photoresist layer on the soft magnetic material film and exposing and developing the photoresist layer to form a pattern of the soft magnetic core, and etching the soft magnetic material film according to the pattern.

[0023] At least one of the above and other features and advantages of the present invention may be realized by providing a method for manufacturing a magnetic field detecting element, including forming a well to a predetermined

depth in a semiconductor substrate, forming a first coil on the semiconductor substrate, the first coil being arranged within the well below an upper surface of the semiconductor substrate, forming a first insulating film on an upper portion of the first coil and forming a soft magnetic core on an upper portion of the first insulating film, forming a second insulating film on an upper portion of the soft magnetic core, and forming a second coil on an upper portion of the second insulating film.

[0024] At least one of the above and other features and advantages of the present invention may be realized by providing a method for manufacturing a magnetic field detecting element including preparing a semiconductor substrate, forming a well to a predetermined depth in the semiconductor substrate, forming a first coil consisting of a plurality of coil lines within the well of the semiconductor substrate, forming a first insulating film on an upper portion of the semiconductor substrate including the well, forming a soft magnetic core on an upper portion of the first insulating film, forming a second insulating film on an upper portion of the first insulating film including the soft magnetic core, and forming a second coil corresponding to the first coil, on an upper portion of the second insulating film.

[0025] Forming the well may include etching inner sidewalls of the well to be gradually inclined from an upper portion of the well to a bottom of the well.

[0026] Forming the first coil may further include forming a first seed film on a surface of the well~~;~~, forming a first plating mold having a plurality of grooves on the first seed film~~;~~, forming a plurality of coil lines constituting the first coil by filling ~~up metal in each groove~~the plurality of grooves of the first plating mold~~;~~ with metal, and removing the first plating mold and the first seed film under the first plating mold.

[0027] ~~Also, the step of forming the second coil further comprises the steps of:~~Filling the plurality of grooves of the first plating mold with metal may include electric plating.

[0028] Forming the second coil may further include forming a via hole by etching the first and ~~the~~ second insulating films on both sides of the soft magnetic core~~;~~ ~~forming a second seed film on an upper surface of the second insulating film on which the via hole is formed; ~~, forming a second ~~plating mold having a plurality of grooves, on the second~~ seed film~~;~~ on an upper surface of the second insulating film in which the via hole is formed, forming a second plating mold having a plurality of grooves on the second seed film, forming a plurality of coil

lines constituting a second coil by filling ~~up metal in each groove~~the plurality of grooves of the second plating mold~~,~~ with metal and connecting the first coil with the second coil through the via hole~~;~~, and removing the second plating mold and the second seed film under the second plating mold.

[0029] ~~Also, a method for manufacturing a magnetic field detecting element according to the present invention,~~Filling the plurality of grooves of the second plating mold with metal may include electric plating.

[0030] The method may further ~~comprises the step of~~include forming a protection film ~~for protecting structures~~on the semiconductor substrate including the second coil to protect a structure formed thereon.

[0031] ~~The foregoing objects~~At least one of the above and other features and advantages of the present invention ~~is~~ may be realized by providing a magnetic field detecting element ~~comprising:~~including a semiconductor substrate~~;~~, a soft magnetic core formed on an upper ~~part~~portion of the semiconductor substrate~~;~~, an insulating film positioned on an upper and a lower ~~parts~~portions of the soft magnetic core~~;~~, and ~~a~~ first and ~~a~~ second coils ~~formed in such a way that those coils~~, each including a plurality of coil lines, formed to enclose the soft magnetic core with the ~~soft magnetic core and the~~ insulating film ~~intervened, and having a~~

~~plurality of coil lines, respectively~~intervening therebetween, wherein a well of a predetermined ~~dept~~depth is formed ~~on~~ in the semiconductor substrate and the plurality of coil lines constituting the first coil are arranged ~~in the inside of~~within the well.

[0032] ~~According to the preferred embodiment of the present invention, a magnetic field detecting element has the construction such that a~~ height of the coil lines and a ~~dept~~depth of the well ~~are~~may be the same.

[0033] ~~Also, the~~The first coil ~~is~~may be positioned at ~~the~~ a lower ~~part of the soft magnetic core and the second coil is positioned at the upper part~~portion of the soft magnetic core~~,~~ and ~~the~~the second coil may be positioned at an upper portion of the soft magnetic core, and the plurality of coil lines of the first and ~~the~~ second coils ~~are~~ may be connected by ~~means of~~ a third coil ~~filled in the~~filling a via hole formed ~~by passing~~ through the insulating film on both sides of the soft magnetic core.

~~Also, the well has an inclined sidewall that is gradually inclined in its inside from its upper part to its bottom.~~

[0034] Inner sidewalls of the well may be gradually inclined from an upper portion of the well to a bottom of the well.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] The above ~~objects~~ and other features and advantages of the present invention will ~~be~~become more apparent ~~from the following detailed description when taken~~to those of ordinary skill in ~~conjunction with the accompanying~~the art by describing in detail exemplary embodiments thereof with reference to the attached drawings~~,~~ in which:

[0036] FIGS. 1A through ~~FIG.~~ 1J ~~are~~ illustrate cross-sectional views ~~for explaining the~~ of stages in a general method for manufacturing a magnetic field detecting element;

[0037] FIGS. 2A through ~~FIG.~~ 2K ~~are~~ illustrate cross-sectional views ~~for explaining~~ of stages in a method for manufacturing a magnetic field detecting element according to an embodiment of the present invention;

[0038] FIG. 3A ~~is~~illustrates a plan view showing a status that a seed film formed on ~~the~~ a semiconductor substrate is removed by a predetermined pattern;

[0039] FIG. 3B ~~is~~ illustrates a plan view showing a cut-off line for cutting off the semiconductor substrate in order to insulate coil lines after forming a plurality of coil lines on the seed film shown in FIG. 3A;

[0040] FIG. 4 ~~is~~illustrates a cross-sectional view ~~for explaining~~ of a modified example of a method for manufacturing a magnetic field detecting element according to an embodiment of the present invention;

[0041] FIGS. 5A through ~~FIG.~~ 5I ~~are~~ illustrate cross-sectional views ~~for explaining~~ of stages in a method for manufacturing a magnetic field detecting element according to another embodiment of the present invention;

[0042] FIGS. 6A through ~~FIG.~~ 6H ~~are~~ illustrate cross-sectional views ~~for explaining~~ of stages in a method for manufacturing a magnetic field detecting element according to still another embodiment of the present invention; and

[0043] FIGS. 7A through ~~FIG.~~ 7H ~~are~~illustrate cross-sectional views taken along line III-III of FIGS. 6A through ~~FIG.~~ 6H, respectively.

DETAILED DESCRIPTION OF THE ~~PREFERRED EMBODIMENTS~~INVENTION

[0044] ~~A preferred embodiment of the~~ Korean Patent Application Nos. 2003-11807, filed February 25, 2003, and 2003-34191, filed May 28, 2003, are incorporated herein by reference in their entirety.

[0045] The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. The invention may, however, be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. In the drawings, the thickness of layers and regions are exaggerated for clarity. Like reference numerals refer to like elements throughout.

[0046] The matters defined in the description such as a detailed construction and elements are nothing but the ones provided to assist in a comprehensive understanding of the invention. Thus, it is apparent that the present invention can be ~~carried out~~ performed without those defined matters. Also, well-known

functions or constructions are not described in detail since they would obscure the invention in unnecessary detail.

[0047] ~~FIG.~~FIGS. 2A through ~~FIG.~~ 2K ~~are~~illustrate views showing ~~process of~~ stages in a method for manufacturing a magnetic field detecting element according to an embodiment of the present invention. Referring to ~~these drawings, the first step in the method for manufacturing a magnetic field detecting element according to an embodiment of the present invention is to form~~ FIG. 2A, an oxidation film (not shown) for electric insulation~~,~~ is formed on a semiconductor substrate 100, and ~~to form the~~ a first seed ~~layer~~ film 102 for plating~~,~~ is formed on ~~that~~ the oxidation film ~~as shown in FIG. 2A.~~.

[0048] ~~After that~~Next, as shown in FIG. 2B, the first seed film 102 ~~spread~~formed on the semiconductor substrate 100 is partially removed ~~with use of~~using a predetermined pattern~~, i.e., the pattern~~ such as that shown in FIG. 3A. The partial removal of the first seed film 102 is for insulating, in a simple manner, a plurality of coil lines constituting ~~the~~ a first coil that ~~would be~~is subsequently formed on the first seed film 102. In FIGS. 2B and ~~that would be described below. Here, the~~ 3A, reference numerals 103 ~~and 107 in FIG. 3A are~~indicates a seed film pattern ~~that would~~to be removed ~~and~~from the first seed

film 102. In FIG. 3A, reference numeral 107 indicates a position of a subsequently formed plurality of ~~the~~ coil lines ~~that would be described below, respectively.~~. As shown in ~~the drawing~~FIG. 3A, the ~~pattern~~ pattern 103 is positioned between ~~a plurality of the~~adjacent coil lines~~, whereby a~~ of the plurality of coil lines 107, and each one of the plurality of ~~the~~ coil lines is partitioned from ~~the neighboring~~adjacent coil lines and connected through the seed film 102 (of FIG. 2B) at ~~the~~ edges~~.~~ thereof 102a. As a result, as shown in FIG. 3B, if four lines 110 connecting the edges 102a of the pattern 103 are cut, the positions of the coil lines are insulated from each other.

[0049] ~~The~~ Partial removal of ~~such~~ the first seed film 102 ~~is performed in the following way, in which the seed film pattern 103 that would be removed by exposing and developing processes is formed after the photoresist is spread on the first seed film 102. At the moment, the~~ of FIG. 2A is performed by first applying a photoresist layer (not shown) on the first seed film 102 and exposing and developing the photoresist layer to form a pattern. Then, the seed film pattern 103 to be removed is etched using the photoresist pattern as an etching mask. The seed film pattern 103 ~~that would~~ to be removed is formed ~~in~~ such ~~a way~~ that parts 102b, where a plurality of coil lines 107 constituting ~~the~~a first coil

106 ~~would~~ (of FIG. 2D) are to be formed, are insulated from each other, and edges 102a are connected to each other as shown in FIG. 3A.

~~Namely, the~~The seed film 102 is electrically connected from a viewpoint of the ~~whole~~entire semiconductor substrate 100, but the parts 102b, where ~~a~~ the plurality of ~~the~~ coil ~~lines~~ lines 107 constituting the first coil 106 ~~would~~are to be formed, ~~is~~ are formed in such a way that the parts 102b ~~could~~can be electrically insulated from each other if the connection parts, i.e., the edges 102a, are cut. Here, generally, the first coil is formed in such a way that an exciting coil and a~~n~~ magnetic field detecting coil are wired one time by turns. Also, only one of either the exciting coil or the magnetic field detecting coil may be wired in a form of a solenoid. ~~After that~~ Then, the pattern 103 of the seed film 102 is removed through etching, ~~then~~ the photoresist is removed, ~~whereby~~ and partial removal of the seed film ~~is completed.~~

[0050] ~~Then, after the photoresist is spread thick on the upper surface of the first seed film~~ 102 ~~that has been partially removed with use of a predetermined pattern 103, the first plating mold 104 having a plurality of grooves 104a is formed by exposing and developing processes (refer to FIG.~~

~~2C), and metal is filled in the groove 104a of the first mold 104, so that a plurality of coil lines 107, 107a constituting~~ is complete, as shown in FIG. 2B.

[0051] Referring to FIG. 2C, a first plating mold 104 is formed on an upper surface of the first seed film 102, which has been partially removed using the predetermined pattern 103, and a thick photoresist layer is formed, exposed and developed on the first plating mold 104, thereby forming a plurality of grooves 104a in the first plating mold 104. Each of the plurality of grooves 104a of the first plating mold 104 is filled with metal, thereby forming a plurality of coil lines 107, 107a, etc., which form the first coil 106, ~~is formed. At the moment,~~as shown in FIG. 2D. If the metal is deposited by electric plating, metal sticks to and grows on the seed film ~~in the lower part of the groove~~ 102 at a bottom of the grooves 104a ~~of the first plating mold 104, whereby a~~ , whereby the plurality of coil lines 107, 107a, etc. is formed ~~as shown in FIG. 2D~~.

[0052] After ~~that, with~~ planarizing or otherwise leveling an upper surface of the first plating mold 104 ~~processed evenly~~, a first insulating film 120 is formed ~~in~~to a predetermined thickness on ~~that evenly processed~~the level upper surface of the first plating mold 104, as shown in FIG. 2E. Then, a soft magnetic material film (not shown) is stacked on ~~the~~an upper ~~part~~surface of the first insulating film

120 and a soft magnetic core 122 is formed by pattern formation and etching ~~(refer to~~of the soft magnetic material film, as shown in FIG. 2F~~)~~.

[0053] ~~In the meantime, the~~An insulating film for forming the soft magnetic core 122 may be formed ~~in~~ such ~~a way~~ that the first plating mold 104 is removed and the insulating material is ~~spread in~~formed on the semiconductor substrate 100 to have a height ~~higher~~greater than ~~a height~~ that of the first coil 106, ~~on the semiconductor substrate 100~~ so that a first insulating film ~~120A~~120a is formed, as shown in FIG.- 4. ~~According to such method, there is a strong point that planarization process needs not to be performed.~~ Forming the insulation film 120a for forming the soft magnetic core 122 according to such a method eliminates the need to perform a planarization process.

[0054] After the soft magnetic core 122 is formed ~~in a foregoing manner~~, a second insulating film 125 is formed ~~in~~ to a predetermined thickness~~,~~ on the first insulating film 120 of the semiconductor substrate 100, as shown in FIG. 2G. Then, ~~a~~ via ~~hole~~ holes 135 for communicating with ~~the~~ coil lines that form both ends of the first coil 106~~, is~~ are formed ~~at~~ through the second insulating film 125.

[0055] ~~After that~~Then, as shown in FIG. 2H, a second seed film 130 is formed on ~~the~~ an upper surface of the second insulating film 125 and a photoresist (not shown) is thickly spread ~~thick~~ on the second seed film 130~~, then a~~. A second plating mold 132 having a pattern that corresponds to a shape of a second coil 136 (of FIG. 2I), i.e., a plurality of grooves 132a, is formed by exposing and developing processes. ~~At the moment~~ At this time, the second coil 136, which corresponds to the first coil 106, may be formed in such a way that an exciting coil and an magnetic field detecting coil are wired one time by turns, or only one of either the exciting coil or the magnetic field detecting coil may be wired in a form of a solenoid.

[0056] ~~After that, metal is filled in the groove~~Each of the plurality of grooves 132a of the second plating mold 132 is then filled with metal by electric plating so that a plurality of coil lines 137, 137a, etc. constituting the second coil 136 is formed ~~(refer to FIG.~~, as shown in FIG. 2I~~).~~. Then, if the second plating ~~mold~~ mold 132 and the seed film under that second plating mold 132 are removed, a magnetic field detecting element having the second coil 136 is obtained, as shown in FIG. 2J.

[0057] In FIG. 2K~~-shows that~~, a protection film 140 for protecting structures including the second coil 136 is formed on ~~the~~ an upper ~~part~~ portion of the second coil 136.

[0058] As previously described, after the first coil 106, the soft magnetic ~~core~~ core 122, and the second coil 136 are formed on the semiconductor ~~substrate~~ substrate 100, ~~a portion~~edge portions 102a ~~that corresponds to the edges~~ of the first seed film 102 ~~is~~ are cut off along a cut-off line 110, as shown in FIG. 3B, by a dicing process~~-as shown in FIG. 3B.~~. Thus, as shown in ~~the drawing, a~~ FIG. 3B, each of the plurality of ~~the~~ coil lines 107 constituting the first coil 106 is electrically separated and insulated ~~each other~~from the others.

[0059] FIGS. 5A through ~~FIG.~~ 5I ~~are~~illustrate cross-sectional views showing stages in another ~~embodiment of the present invention. A~~ method for manufacturing a magnetic field detecting element according to ~~the~~an embodiment of the present invention~~-is characterized in applying the characteristic structure and process of the present invention in forming the second coil 136 as well as the above-described first coil 106, which will be described in the following.~~.

[0060] ~~Since the~~In FIGS. 5A through 5I, processes up to ~~the~~a process for forming the second insulating film 125 after forming the oxidation film on the semiconductor substrate 100, as shown in FIGS. 5A through 5E, are the same as those in the foregoing embodiment shown in FIGS. 2A through 2G. Therefore, a detailed description thereof will be omitted.

[0061] As shown in FIG. 5F, a second seed film 141 is formed on an upper surface of the second insulating film 125, and the second seed film 141 is partially removed in a manner similar to that used for partial removal of the first seed film 102. Namely, after a photoresist (not shown) is thickly spread on the second seed film 141, a seed film pattern 141a to be removed is formed by exposing and developing processes. At this time, the seed film pattern 141a to be removed is formed in such a way that each one of the plurality of coil lines 137 constituting the second coil 136 is insulated from each adjacent coil line, but each of the plurality of coil lines 137 is connected at edges of the seed film 141. More specifically, the seed film pattern 141a is formed in the same manner as the seed film pattern 103 of the above-described first seed film 102.

Therefore, if the semiconductor substrate 100 is cut off along its edges, each of the plurality of coil lines 137 is electrically separated and insulated from

the others. It is preferable that a cut-off line (not shown) of the second coil 136 is overlapped on the cut-off line 110 of the first coil 106 so that the ~~process of the foregoing embodiment (refer to FIG. 5A through FIG. 5E), detailed description thereof will be omitted.~~

~~Next, as shown in FIG. 5F, a second seed film 141 is formed on the upper surface of the second insulating film 125, and that second seed film 141 is partially removed by the same method and pattern as those of the first seed film 102. Namely, after the photoresist is spread on the second seed film 141, a seed film pattern 141a that would be removed is formed by exposing and developing processes. At the moment, the seed film pattern 141a that would be removed, is formed in such a way that a plurality of the coil lines 137 constituting the second coil 136 is insulated each other in their sides and a plurality of the coil lines 137 is connected by means of the edges of the seed film 141. Namely, the seed film pattern 141a is formed in the same manner as the pattern 103 of the above-described first seed film 102.~~

[0062] ~~Therefore, if the semiconductor substrate 100 is cut off along its edges, the coil lines 137 are electrically separated and insulated. At the moment, it is preferable that the cut-off line (not shown) of the second coil 136 is overlapped~~

~~on the cut-off line 110 of the first coil 106 so that a plurality of the~~ pluralities of coil lines 107, 137 constituting the first and the second coils 106, 136, respectively, ~~is~~ are separated and insulated simultaneously by ~~one time of~~ a single dicing process.

[0063] After ~~that,~~ formation of the seed film pattern 141a, a photoresist (not shown) is spread ~~thick~~ thickly on ~~the~~ an upper surface of the second seed film 141 that has been partially removed by a predetermined pattern, ~~then~~ and a second plating mold 142 having a pattern that corresponds to the second coil 136, i.e., a plurality of the grooves 142a, is formed by exposing and developing processes ~~(refer to FIG.~~, as shown FIG. 5G~~). After that~~. Then, as shown in FIG. 5H, ~~metal is filled in the groove~~ each of the plurality of grooves 142a of the second plating mold 142 is filled with metal so that ~~a~~ the plurality of ~~the~~ coil lines 137, 137a, etc. is formed.

[0064] ~~Then~~ In FIG. 5I, a protection film 150 is ~~spread on the~~ then formed on an upper ~~part of the structures~~ portion of a resultant structure including the second plating mold 142~~, and finally~~. Finally, the semiconductor 100 is cut off along edges thereof according to a cut-off line 110 by the dicing process ~~(refer to FIG.~~, as shown in FIG. 3B~~)~~.

~~Since the plating mold needs not to be removed for removal of the seed film as described above according to the method for manufacturing the magnetic field detecting element of the present invention, it is possible to provide the magnetic field detecting element such that the manufacturing process is simple and there are small restrictions in materials used for the insulating film.~~

[0065] ~~The accompanying FIG.~~According to methods for manufacturing a magnetic field detecting element of the present invention as described in the above embodiments, since a plating mold does not need to be removed to perform partial removal of a seed film, it is possible to provide a simplified manufacturing process for a magnetic field detecting element in which a material used for an insulating film is relatively unrestricted.

[0066] FIGS. 6A through ~~FIG.~~ 6H ~~are drawings for explaining~~ illustrate stages in a method for manufacturing a magnetic field detecting element according to still another embodiment of the present invention~~, and FIG.~~. FIGS. 7A through ~~FIG.~~ 7H ~~are~~illustrate cross-sectional views taken along line~~s~~ III-III of FIG. 6A through FIG. 6H, respectively.

[0067] Referring to FIGS. 6H and ~~FIG.~~ 7H, ~~the~~a magnetic field detecting element manufactured according to ~~the~~ a manufacturing method of the present invention~~, comprises:~~ includes a semiconductor substrate 200~~;~~, a soft magnetic core 220~~; the~~, first and ~~the~~ second insulating films 230, 240 positioned at ~~the~~ upper and ~~the~~ lower ~~parts~~portions of the soft magnetic core 220~~;~~, and ~~the~~ first and ~~the~~ second coils 250, 260 formed in such a ~~way~~manner that ~~those~~the first and second coils 250, 260 enclose the soft magnetic ~~core~~ core 220 with the ~~soft magnetic core 220 and the~~ insulating films 230, 240 ~~intervened, and~~ intervening between the soft magnetic core 220 and the first and second coils 250, 260, respectively, the first and second coils 250, 260 each having a plurality of coil lines 251, 252,..., and 261, 262,..., respectively.

[0068] The first coil 250 is positioned ~~on the~~at a lower side of the soft magnetic ~~core~~ core 220, and the second coil 260 is positioned ~~on the~~ at an upper side of the soft magnetic core 220. ~~Particularly~~ More particularly, the semiconductor substrate 200 has ~~an approximately rectangular~~ a well 211 ~~that collapses in a predetermined dept~~ formed therein to a depth (D of FIG. 6B) from ~~its~~an upper surface of the semiconductor substrate 200, and the first coil 250 is arranged within the ~~inside of that well~~ well 211 ~~so that~~. Therefore, the first coil 250 may

not be exposed to the surface of the semiconductor substrate 200~~according to the characteristics of the present invention.~~.

[0069] ~~The~~A height (H of ~~a~~ FIG. 6B) of the plurality of ~~the~~ coil lines ~~51~~251, 252, etc. constituting the first coil 250 formed within the ~~inside of the~~ well 211 is the same as the ~~dept~~depth of the well 211. Therefore, ~~the~~an upper surface of the coil lines 251 maintains ~~the~~a same plane as the upper surface of the semiconductor substrate 200.

[0070] As described above, unlike ~~the~~ a conventional ~~art~~magnetic field detecting element, since the first coil 250 ~~is~~does not ~~projected to~~project beyond the upper surface of the semiconductor substrate 200, but is formed in the well 211 of the substrate 200 to have an upper surface at a same plane as the upper surface of the semiconductor substrate 200~~in the inside of the well 211 of the~~, it is easy to planarize the semiconductor substrate 200, ~~it is easy to perform planarization of the semiconductor substrate 200 in which the first coil 250 is formed~~ and it is possible to make ~~very thin the~~ a thickness of a planarization material, ~~for example,~~such as the insulating films 230, 240, to be thin.

[0071] Therefore, performance deterioration of ~~the~~a soft magnetic core ~~220~~ generated due to unevenness ~~of the~~in a conventional semiconductor substrate

and difficulty in an etching process generated due to ~~the characteristics that the thickness of the~~a thick insulating film ~~is thick, are resolved and~~in a conventional semiconductor substrate do not occur in the magnetic field detecting element ~~of high sensitivity, wherein the pitch between the coils is fine, is possibly~~ manufactured according to an embodiment of the present invention, in which a magnetic field detecting element having high sensitivity and fine pitch between coils thereof may be formed.

[0072] ~~In the meantime, the~~ The well 211 has an approximately rectangular ~~well 211 is formed in such a way that the well has an inclined sidewall that is~~ shape, but has inner sidewalls of that are gradually inclined ~~in its inside~~ from ~~its~~an upper ~~part~~portion thereof to ~~its~~a bottom thereof, and which may be formed by a variety of the etching technologies generally well known in the art.

[0073] Also, as shown in FIG~~. 7F and FIG.~~S. 7G and 7H, the first and ~~the~~ second coils 250, 260 are connected~~,~~ by means of a third coil 300 ~~filled~~, which is formed upon formation of the second coil 260, ~~to~~ by filling with metal through holes 290, 290' formed on both ends of the soft magnetic core 220 ~~by~~ and passing through the first and ~~the~~ second insulating films 230, 240.

~~The~~A method for manufacturing the magnetic field detecting element of

FIGS. 6H and 7H according to an embodiment of the present invention will now be described ~~in the following.~~

[0074] ~~FIG.~~with reference to FIGS. 6A through 6G and FIGS. 7A ~~are~~through 7G.

[0075] FIGS. 6A and 7A illustrate cross-sectional views showing ~~that~~ a first plating mold 270 for forming the first coil 250 ~~is~~ formed on ~~the~~an upper surface of the semiconductor substrate 200 in which the well 211 is formed._ Although not specifically ~~not~~ shown in ~~the drawing~~FIGS. 6A or 7A, a seed film for plating is formed on ~~the~~a surface of the well 211, and the first plating mold 270 is formed by exposing and developing processes after ~~the~~ a photoresist is thickly spread ~~thick~~ on the seed film. ~~In the drawing, the reference numeral 270a is a groove of the~~ The first plating mold 270 has a plurality of grooves 270a.

[0076] If the seed film and the first plating mold 270 are removed after ~~metal is filled in such groove~~the plurality of grooves 270a of the first plating mold 270 are filled with metal by means of ~~the~~an electric plating method so that the plurality of coil ~~line~~lines 251, 252 is formed, the first coil 250 as shown in FIGS. 6B and 7B is formed in ~~FIG. 6B and FIG. 7B is formed on~~ the well 211 of the semiconductor substrate 200. ~~At the moment, the~~ The first coil 250 ~~is~~does not

~~projected to~~project above the surface of the semiconductor substrate 200 but ~~formed~~formed is in the same plane as the semiconductor substrate 200.

[0077] After that, as shown in FIGS. 6C and ~~FIG.~~ 7C, an insulating material is spread on the upper surface of the semiconductor substrate 200 in which the first coil 250 is formed, so that ~~a~~the first insulating film 230 for planarization and insulation~~,~~ is formed. ~~At the moment, since the~~ The first coil 250 formed in the well 211 is not projected ~~to the~~ beyond an upper surface of the semiconductor substrate 200, but ~~maintains the~~an upper surface of the first coil 250 is at a same plane as the upper surface of the semiconductor substrate 200, so that planarization of the semiconductor substrate~~, it is easy to perform planarization and it~~ 200 is ~~possible to make~~ easily performed, and the insulating film ~~230~~230 may be formed to be very thin as well.

[0078] After the first insulating film 230 is formed, a soft magnetic material film is stacked on the first insulating film 230 and ~~a~~the soft magnetic core 220 is formed by pattern formation and etching of the soft magnetic material film, as shown in FIGS. 6D and ~~FIG.~~ 7D.

[0079] ~~After that~~Then, an insulating material is ~~spread in~~ formed to a predetermined thickness~~,~~ on ~~the~~an upper ~~part~~surface of the first insulating film

230 including the soft magnetic ~~core~~ core 220, so that a second insulating film 240, as shown in FIGS. 6E and ~~FIG.~~ 7E, is formed.

[0080] ~~After that, the portions that~~Portions of the second insulating film 240, which correspond to ~~the~~ both ends of the soft magnetic core 220 ~~of the second insulating film 240~~, are etched so that ~~the~~ through holes 290, 290', as shown in FIG. 7F, are formed, and ~~the~~a process for forming the second coil 260 ~~is proceeded.~~ proceeds. At ~~the moment~~this time, since the thickness of the first and the second insulating films 230, 240 is ~~formed~~ very thin, according to ~~the characteristics~~a feature of the present invention ~~upon~~, etching for formation of the through holes 290, 290'~~, the etching process could~~ may be performed in a simple manner. Also, since it is possible to realize ~~the~~ fine-pitched coils due to such simplification of the process, ~~the sensor of~~ a magnetic field detecting element having high sensitivity ~~is possibly~~ may be manufactured.

[0081] The formation of the second coil 260 is performed in such a ~~way~~manner that ~~firstly the~~a seed film (not shown) is formed on ~~the~~an upper surface of the second insulating film 240 in which the through holes 290, 290' are formed, and ~~the~~ a photoresist is ~~spread~~formed on ~~that~~ the seed film~~, then~~. Then, the second

plating mold 280 having a plurality of grooves 280a is formed by exposing and developing processes as shown in FIGS. 6F and ~~FIG.~~ 7F.

[0082] After the ~~foregoing~~ second plating mold 280 is formed, ~~metal is filled in the groove 280a~~ each of the ~~plating mold 280 by means~~plurality of ~~the~~ grooves 280a is filled with metal by means of electric plating ~~method~~, so that a plurality of coil ~~line~~lines 261, 262 forming the second coil 260 is formed, as shown in FIGS. 6G and ~~FIG.~~ 7G. At ~~the moment, metal is filled in~~this time, the through holes 290, 290'~~, whereby~~ are filled with metal, thereby forming a third coil 300 connecting the first coil 250 at ~~the~~ a lower side ~~is connected~~of the soft magnetic core 220 to the second coil 260 at ~~the~~an upper side ~~by means of a third coil 300 that is filled in the through holes 290, 290'.~~of the soft magnetic core 220. Therefore, the coils 250, 260 are realized in such a ~~way that these coils~~manner that the coils 250, 260 enclose the soft magnetic core 220.

[0083] If the seed film and the second plating mold 280 ~~is~~ are removed after the coil line 261 is formed, the second coil 260 is exposed, whereby a thin type magnetic field detecting element as shown in FIGS. 6H and ~~FIG.~~ 7H is manufactured. Here, the magnetic field detecting element manufactured by the present invention ~~could~~may reduce ~~the whole~~an entire height of the magnetic

field detecting element by as much as the ~~dept~~depth of the well 211 formed ~~on~~in the semiconductor substrate 200, thus a thin structure ~~is possibly~~ may be realized.

[0084] ~~In the meantime, on the~~On an upper ~~part~~surface of the semiconductor substrate 200, a protection film for protecting ~~the~~ structures formed thereon ~~could~~may be formed.

[0085] As is apparent from the foregoing, according to the present invention, since ~~the~~a first coil is not projected ~~to the~~beyond an upper ~~part~~surface of ~~the~~a semiconductor substrate but is positioned within a well formed in the ~~inside of the well~~semiconductor substrate, it is easy to perform planarization of the semiconductor substrate, and it is possible to ~~make thin the~~reduce a thickness of ~~the~~a planarization material as well. Therefore, performance improvement of ~~the~~a soft magnetic core is expected ~~thanks~~due to improvement in ~~planarization~~a degree~~, and~~ of planarization. Further, simplification of ~~the~~an etching process for forming ~~the~~a through hole is expected ~~thanks~~due to realization of ~~the~~ a thin insulating film. Also, ~~the~~a pitch between ~~the~~ coils ~~could~~may be reduced ~~thanks~~due to simplification of the etching process, thus ~~the~~ sensitivity of ~~the~~a sensor ~~could~~may be improved.

[0086] ~~Namely, according~~According to the various embodiments of the present invention, manufacturing of ~~the~~a magnetic field detecting element is simplified, whereby productivity improvement is expected and ~~the~~a thin-type element of good sensitivity ~~is possibly~~may be manufactured as well.

[0087] ~~While the invention has been shown and described with reference to certain preferred embodiments thereof to explain the principle of the present invention~~Exemplary embodiments of the present invention have been disclosed herein and, although specific terms are employed, they are used and are to be interpreted in a generic and descriptive sense only and not for purpose of limitation. Accordingly, it will be understood by those ~~skilled~~of ordinary skill in the art that various changes in form and details may be made ~~therein~~ without departing from the spirit and scope of the present invention as ~~defined by~~set forth in the ~~appended~~ following claims. ~~Therefore, all such proper modifications, changes and equivalents of the embodiments of the present invention will fall within the scope of the invention.~~